An Investigation of the Effects of integrating Biotechnology-related Case Studies and Guided Inquiry into the Advanced Placement Biology Curriculum on Student Interest and Achievement.

Melissa Guinta
AP Biology/General Biology Teacher
Umatilla High School
Lake County Public Schools

quintam@lake.k12.fl.us
Abstract:

This action research will present the findings of using case studies and guided inquiry, along with biotechnology to measure if the interest and achievement of students is increased in AP Biology. During the 2012-2013 school year, two of the six units within the AP Biology curriculum will be reconstructed to include the use of case studies and biotechnology based labs to teach the units in the style of guided inquiry. Student interest will be measured before and after each unit to see if they benefited from the adapted curriculum. Their unit test scores will also be analyzed to see if student mastery of concepts was achieved.

Rationale:

I have always wanted to be a “guide” for students and not a wise figure who shares my knowledge while students stare and record my thoughts. When I entered the profession of teaching six years ago I found that the reality of teaching youth today wavered between two widely accepted forms of instruction that were practiced in my school by respected teaching veterans. One version was a science teacher who was a stern but warm lecturer and whose students applied learning only through labs, and the other was an overly energized teacher who did labs exclusively and lost students when it came to content. Before working toward the version of teaching that I wanted to achieve, I gave myself time to learn from my peers and become more comfortable with my content subject. I also attended every teacher learning opportunity I could sign up for and raced back to try the topic of interest with my students. I didn’t realize that by trying so many new methods I was getting to a point that I may have been negatively affecting my goal to become a teacher who engages and helps students build a solid knowledge base in Biology.

Now that my content knowledge is stronger and I have been able to explore various methodologies it is time to refine my teaching into a streamlined style. Teaching does not have to be lecture verses lab, but should be an incorporation of active learning that merges lecture and lab and therefore enhances the learning experience (Azzawi & Dawson, 2007). Through experience I have also learned that the stories and video clips that I often incorporate into lessons appear to increase student interest and help keep them engaged in the material. This led me to desire to develop and adopt the use of case studies into my AP Biology curriculum in order to test the idea of teaching through guided inquiry. The case study method has long been used for developing reasoning skills and to connect in-class learning with the reality outside the classroom (Murphy & Smith, 1998). The Bench to Bedside program demonstrates this by using the presentations by speakers to pique our interest and connect it to the labs that they demonstrated with us during the program.

I wanted to use this technique in my own classrooms which led me to choose the incorporation of biotechnology and case study investigation into my curriculum. I plan on incorporating this methodology into Unit 1 at the beginning of the year, and as research suggested use an issue that a student has just seen mentioned in the media (Herreid, 1997). The second case study will be incorporated into Unit 4 and will draw on
another important aspect of using case studies in teaching, the introduction of an issue that causes students to personalize with a topic and also generates empathy (Herreid, 1997). Using these case studies to create an environment of guided inquiry will hopefully teach students to make linkages and integrate material, while also giving students a sense of accomplishment (Murphy and Smith, ). It has been shown that using this type of analysis of an issue is the way real science works, with incomplete data and collection of information that leads to predictions which result in the gathering of more data (Herreid, 2007). Therefore, the purpose of this study is to describe the effects on student interest and achievement of integrating biotechnology-related case studies and guided inquiry into units within the Advanced Placement Biology curriculum.

**Action Research Intervention:**

I will be incorporating the use of case studies and guided inquiry into Unit 1 and 4, of the six units in my AP Biology Curriculum. One of these I have created myself and will use with Unit 1, The Chemistry of Life. In this unit, students will use a three part case study to learn the concepts of the properties of water, chemical bonding, macromolecules, chemical reactions, and enzymes. Images of The Senator, the 3,500 year old cypress tree that lived in Sanford, will be used as engagement to introduce the concepts of the chemicals of life, and the properties of water required to provide water to a 318 foot tree. A follow up article concerning the burning down of the tree will be used to introduce chemical bonding and the chemical reaction of fire, along with the construction and deconstruction of macromolecules. The third and final portion will involve an introduction to the tree’s arsonist, a local meth addict, and address the physical effects of meth and the health of the arsonist by using “Mouse Party” from the website Learn Genetics at the University of Utah (http://learn.genetics.utah.edu). Students will also read a current science research article on damages to the liver that meth causes, and will address the role of liver enzymes by completing a lab.

The second inquiry lesson will take place during Unit 4, from Gene to Protein. In this unit students will learn the concepts of Mendelian inheritance, transcription and translation, protein folding, mutations, environmental factors on phenotypes. Students will be engaged by reading a blog from a father who had a son with Pompe disease. This will provide a platform on which to build knowledge of genetics through lecture and pedigree analysis. The additional unit concepts will be taught by following the layout and design of the CPET curriculum unit The Pompe Predicament, created by Julie Bokor.

**Connection to Bench to Bedside Summer Institute:**

Use of laboratory experiences practiced in Bench to Bedside:

- Pompei Predicament
- Protein folding
- Water kits
Data Collection and Analysis:

Data will be gathered from my two AP Biology classes, a total of 36 students with 7 in 12th grade, 16 in 11th grade, and 13 in 10th grade. Out of the 36 students, 16 are male and 20 are female.

Within these two classes, students will be required to take a pre-survey before the two focus units and a post survey after the units are complete. Nine of the survey questions use a Likert scale to measure student response to the way the unit was set up and the use of case studies incorporated into the unit. The final question is open-ended, asking the students to describe their level of interest in the unit.

Along with gauging student responses to the curriculum, I will be measuring scores on Unit tests and tracking their academic achievement. Unit test scores will be graphed in and survey data will be provided in a table.

Budget and Budget Justification:

- Movie Extraordinary Measures $10
- Supplies for protein folding lab and Pompe testing kits $40
- 3-D Molecular Designs 6-Cup Water Kit Set (WK-06) Price: $232

References


*APA formatting by BibMe.org.*
Time Line:

Unit 1: The Chemistry of Life: (Campbell, Chapters 1-5)

Part 1 (1.5 weeks/90 minute classes)

Sci Method:

- Picture of the Senator: How can a tree grow so large? What substances is it made of?
- Students read short summary in Helmont’s words of his historic experiment.
  - Discuss constants, manipulated variables vs. dependent, extensions of that experiment, validity,
  - Fruit fly lab – food preference

Chemistry Review

- Article about Senator burning down; What do you need for fire to occur? Is fire an exothermic or an endothermic reaction? – record in lab books
  - Light candle – record observations about the flame, discussion of what elements make up wax?
  - Put metal probe in closest to wick in white part of the flame, observe tip; put probe in yellow part of flame observe carbon residue on tip.
  - Chemical equation: Hydrocarbons + oxygen \(\rightarrow\) water + O2 + CO2
- Mini-lecture/Notes: efficiency of reaction, chemical reactions, types of bonding, elements required for life, trace elements, periodic table
- Nova video clips (chemical reaction of fire)
  http://www.pbs.org/wgbh/nova/physics/science-fire.html
  http://www.pbs.org/wgbh/nova/education/physics/fireworks-making-color.html
- TED Talks: Van der Waals Chemical Bonds
  http://www.ted.com/talks/robert_full_learning_from_the_gecko_s_tail.html

Part 2 (1.5 weeks/90 minute classes)

Demo of capillary action, bring back to size of the Senator (118 ft): what is it made of (major atoms involved in living organisms), how did it get so tall and still have water traveling against gravity (properties of water)

- Water Properties Intro with Demo of specific heat of water using balloon, water, and fire:
- Students work through mini labs on each of the properties of water
  - Materials
    - Water Lab kit and lessons (CPET Introduced)
    - Glass plates, objects, water dish
- Small group follow up questions
Part 3 (1.5 weeks, 90 minute classes)

Meth and the Senator: watch video clip on drug addict arrested for arson.

- Using molecular model kits construct biomolecules from monomers
  - Large group analysis and discussion of macromolecules and roles in the body
- Identify the functional groups present in Meth and discuss how this is used in the body.
- Introduce Meth effects with Learn Genetics Mouse Party
  - Small group read of Scientific article on Meth and Liver enzymes
  - AP Enzyme Lab with Liver, testing variables for enzyme function

Extra credit reading: Diethylene-glycol and Death, Generic Drug scandal (CPET Introduced)

Unit 4: From Gene to Protein: (Campbell, Chapters 16-21)

Part 1 (1 week/90 minute classes)

Students read Blog and Pompe jigsaw: learn fundamentals of pompe disease, relate knowledge back to prior unit on cell and genetic principles.

- Mini lecture with Story/timeline of how science works
  - Activity: put in order timeline of founders of DNA as the magic bullet
  - DNA paper models and replication simulation diagram and notes with questions.

Part 2

Watch Video of individual with Pompe

- Mini lecture: Transcription/Translation major concepts.
  - Activity: learn through interactive activity of creating sentences about pompe from matching codons to anticodons.
- Lab based on Science Take out kit (produced by teachers) Building proteins
- Mini lecture: Mutation Discussion.
  - Biotech color assay to identify patients with mutation.

Extra Credit: Research Topic: Biotechnology and Viruses: potential vector for treatment?